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THE JUBILEE OF THE COAL TAR COLOR INDUSTRY.
THE INFLUENCE OF SIR WILLIAM HENRY PERKIN'S DISCOVERY UPON OUR SCIENCE.[1]

I NEED hardly assure you how highly honored I feel to be permitted to speak here to-night. Yet I am fully aware that the committee did not select me because it considered me the most competent of our chemists to respond to this subject, but because so many of our colleagues refused to be heard, fearing the arduous labor of condensing this vast material within the limits of a fifteen-minute address, when fifteen hours could be devoted to it with much less difficulty and work. With me, however, it was a labor of love, and I accepted with pride and pleasure, inspired by the wonderful development of this industry in which I have been an attentive watcher and a modest coworker, it being just twenty years since, in collaboration with Professor Bernthsen, I began the investigations which finally culminated in the discovery of the constitution of the dyestuffs of the safranine series. Above all, I have been inspired in my task by the genial personality and refined modesty of our distinguished guest, Sir William Henry Perkin, with whom I had the pleasure of becoming more intimately acquainted during last year's meeting of the Society of Chemical Industry in London. It must be a sincere source of congratula-

[1] Given at the banquet given to Sir William Henry Perkin, at Delmonico's, New York City, October 6, 1906.

tion to us that he has braved the perils of a long ocean voyage to honor us with his presence at our celebration of the semi-centennial of the coal tar industry, initiated by the discovery of Perkin's mauve. Only fifty years ago, while engaged in research, having for its object the artificial production of quinine, Perkin, then an eighteen-year old assistant of Hofmann, obtained a muddy, dark precipitate, from which he first endeavored to extract certain colorless crystalline substances which might adequately explain the reaction under observation. One day, however, the thought occurred to him to utilize this colored precipitate itself for the dyeing of silk. It is hard to realize to-day what an epoch-making idea it was at that time to dye fabrics with a substance evolved in the laboratory and having no relation whatever to the dyestuffs then known. It was truly the spark of genius which led Perkin to investigate the dyeing properties of that dark-colored precipitate which would have been cast away by any other scientist of that period and particularly by his master, Hofmann, who objected to experimenting with anything which did not crystallize and who had at that time a strong aversion to working with substances which were colored. For the latter, when produced in reactions, were generally regarded as secondary products and every endeavor was made to get rid of them, so that the other substances associated with them might be examined.

But however great the discovery of mauve, and however much we must admire the courage of the youth who undertook its technical production, yet these steps were only trivial incidents in the immense revolution brought about by Perkin's genius. The greatest obstacles encountered by him, and the most difficult task to be performed, was when he attempted to sell the color to dyers and printers. At that time men of this class worked by the rule of thumb with secret recipes, mostly inherited from their forefathers, and their formulæ, although applicable to natural colors, were not suitable for mauve. Thus Perkin and his associates had to prepare new directions for dyeing and printing and to induce those ultra conservative dyers to adopt the new methods. It has been almost forgotten that Perkin was the first to introduce the method of dyeing silk in a soap bath which is commonly employed to-day for all artificial dyestuffs, and that he and Pullar first made use of the mordanting of cotton with the insoluble inorganic compounds of tannin.

Thus the introduction of mauve completely changed the art of dyeing and printing, simplifying the processes and substituting for the old time formulæ the scientific recipes furnished by the color manufacturers of the present day. After Perkin had thus removed the obstacles in the path of practical application, it became comparatively easy to introduce other coal tar colors.

But Perkin also paved the way for the discovery of the later coal tar colors by creating commercially aniline and benzole, which up to his time had only been laboratory curiosities. Of the three methods available for obtaining aniline he selected as the most promising the reduction of nitrobenzol, made by nitration of coal tar benzol, and the production of aniline from this source led, shortly after the discovery of mauve, to the discovery of magenta, which opened up a new and immense field for this industry. Aniline from benzole was later found to contain toluidine, which is not present in aniline from indigo or that obtained directly from coal tar, and Perkin truly said in a lecture delivered December 7, 1868:

> Had the aniline contained in coal tar or the aniline obtained from indigo been employed for the preparation of mauve, instead of that pre-

pared from commercial benzol, magenta and its train of colored derivatives would in all probability have remained unknown to the present day from the simple fact that magenta can not be produced from pure aniline, a second body being also required.

The industry thus initiated with a violent impetus soon showed its revolutionizing tendencies and its vitalizing power in almost every branch of human endeavor. To-day about 2,000 individual dyestuffs are known, giving the whole range of the colors of the rainbow, and complying with every demand of taste, fashion and stability. They surpass in beauty and brilliancy the colors supplied by nature, and, contrary to the impression prevailing among the public, the shades obtained with some of them are faster to the influence of time, light and chemicals than the fastest which nature produces.

The greatest triumph of this branch of the industry was the artificial production of alizarine and indigo. In the technical production of the former our distinguished guest has played a prominent part, solving the problem of its manufacture simultaneously with Graebe, Liebermann and Caro, whose English patent antedates that of Perkin by one day, and for the first synthesis of indigo cinnamic acid was successfully employed which was originally obtained from coal tar by Perkin.

Coal tar colors, however, are not only used for the dyeing of textile fibers, like wool, silk, cotton, linen, jute, ramie, etc., but for a host of other materials.

The lady's hair is gray, or of a hue not fashionable at the time—coal tar colors will assist her in appearing youthful and gay. In eating the luscious frankfurter your soul rejoices to see the sanguineous liquid oozing from the meat—alas coal tar colors have done it, and friend Wiley can prove it. The housewife selects a bright green broom, on account of its anticipated good wearing quality, but finds, to her sorrow, that coal tar colors furnished the freshness. The product of the hen is replaced by yellow coal tar colors in custard powders, and butter is colored yellow when the dyestuff laboratory of the cow is on a strike. Leather, paper, bones, ivory, feathers, straw, grasses, are all colored, and one of the most interesting applications is the dyeing of whole pieces of even the bulkiest furniture by dipping them in large tanks containing the dyestuffs, which transforms the wood into walnut, mahogony at your command, as carried out in our big factories in Grand Rapids and elsewhere.

As coal tar colors are used on this enormous scale, so they are also employed in a liliputian manner, for staining specimens for examination under the microscope, enabling us to detect and identify bacteria, the finest nerve-ends and other minute elements of animal tissues, and by means of such staining methods, especially with methylene blue, Koch discovered the bacillus of tuberculosis and cholera, and initiated the modern battle against preventable infectious diseases. In reciprocation for the excellent reagents supplied him by the dye industry, the histologist brought about the discovery of a new and very important class of colors, and as this instance is one of the most striking demonstrations of the interdependence of practise and theory, I shall relate it to you. In 1886 Ehrlich observed that methylene blue and some of its congeners were the only colors which stained the living nerve tissue, and in order to determine whether this remarkable property was due to the peculiar constitution of methylene blue or to the presence of sulfur, he found it desirable to experiment with a substance analogous to methylene blue, but in which the sulfur was replaced by oxygen. He applied to Dr. Caro requesting him to assist him in his work by furnishing him

the material necessary for his experiments.

As a substance of this constitution was then unknown, it was made to order, and in the course of this research the valuable class of rhodamine colors was discovered. Thus experiments with nerve tissues gave birth to the manufacture of coal tar colors of the greatest importance in the textile industries.

The dyestuffs methylene blue and some others are also of great value as internal remedies, and the former is strongly recommended by one of the greatest American authorities for the relief of pain in that horrible disease—cancer.

The medicinal properties of the coal tar colors lead us to that branch of the industry which is next in importance, namely, the coal tar remedies. Incidentally, it may be mentioned here that before these so-called synthetics were introduced, Kolbe had succeeded in 1874 in artificially preparing from coal tar salicylic acid, which up to that time was exclusively a product of nature. Salicylic acid has been, and is still to-day, used extensively as a remedy against rheumatism.

The industry of synthetic drugs owed its origin also to the efforts of chemists to produce quinine artificially. Experiments had shown that by decomposing quinine a substance called quinolin was formed, and the latter was likewise found to exist in coal tar. It was then assumed that quinine must in some way be derived from quinolin, and that perhaps other derivatives of quinolin might possess properties similar to quinine. This trend of thought led to the discovery of the quinolin derivatives, thallin and kairin, which, however, were soon discarded on account of their drastic action and to-day possess only historical interest.

In 1883 Knorr, starting from erroneous deductions concerning the constitution of quinine, and also misinterpreting the constitution of some of the products obtained in his research, inspired the pharmacological study of a substance afterwards called antipyrin. This product proved to be of the greatest value in medicine and was the first successful synthetic coal tar remedy in the market.

Shortly after the introduction of antipyrin a fortunate accident gave this modern art an unexpected stimulus, diverting the investigation from quinine and uncovering an entirely new field. Kahn and Hepp, two physicians connected with the Strassburg University, were on terms of friendship with a chemist of the Hoechst Works, where Knorr's antipyrin was being manufactured, and requested him, in 1886, to send them some chemically pure naphthalene, which they desired to use internally in the case of a patient suffering with some skin disease. They received the substance, and on administering it found that while it failed to exhibit the expected effect, it promptly reduced the existing fever. When the supply of naphthalene was almost exhausted, they wrote for a further quantity; but, to their great astonishment, the second supply, unlike the first, did not manifest any antipyretic action, and on comparing the two, they soon discovered that a mistake had occurred somewhere. An investigation showed that when the first request was received the laboratory boy was directed by the chemist to fill a bottle with naphthalene and mail it to his friends, but through an error some acetanilid was sent instead, while the second time the chemist himself filled the bottle correctly. Thus through an accident acetanilid was introduced into medicine, a remedy which to-day is used by the ton as an antipyretic and antineuralgic, and through the irony of fate the most powerful competitor of antipyrin was discovered as the result of a mistake made in the very factory which

was realizing enormous profits from the production of antipyrin.

When it was recognized that the acetylization of an amine produced a body of so much value, this process was tried with many amines and other suitable substances, and in consequence such important remedies as phenacetin were obtained, while by substituting lactic acid for acetic acid, lactophenin was prepared, and by means of amidoacetic acid, a drug named phenocoll.

After chemical researches had shown that the active principles of vegetable purgatives, such as rhubarb, senna, cascara-sagrada and aloes were anthraquinone derivatives, synthetic preparations of this class, which therefore are closely related to the alizarine colors, are now brought into the market. These new remedies have the advantage over the crude drugs of greater uniformity of action and exactness in the dosage.

The active principle of the suprarenal gland first isolated and investigated by an American scientist, a substance of surprisingly simple chemical constitution, has been obtained from coal tar, and it is said that this synthetic product is now marketed, and from experiments carried out in Europe and in the large works of Parke, Davis & Company in this country, we may expect that derivatives of this body will soon appear which will be even superior in their pharmacological effect to nature's product.

About the time that the first synthetics were brought out, a very curious chemical was discovered also by American ingenuity, which is to-day not only used for medicinal, but also on a large scale for industrial purposes. I refer to saccharine, a substance derived from coal tar, which is 550 times sweeter than sugar, and is the first representative of the class of artificial sweeteners. It may be of interest to relate an instance showing how purely theoretical investigations may lead to the building up of an important industry.

Dr. Fahlberg, working under the direction of Professor Ira Remsen at Johns Hopkins, was experimenting with coal tar derivatives from a purely scientific point of view. Before leaving the laboratory one evening, he thoroughly washed his hands, and was under the impression that he had taken every pains in doing so. He was, therefore, greatly surprised on finding that, during his meal, when carrying bread to his mouth, the hands had a sweet taste. He suspected that his landlady had unintentionally sweetened the bread and called her to account. They had a little discussion, from which she emerged the victor. It was not the bread that tasted sweet, but his hands, and, much to his surprise, he noted that not only his hands but also his arms had a sweet taste. The only explanation that he could think of was that, notwithstanding the thorough washing, he had brought some chemical along from the laboratory. Rushing back to it and carefully investigating the taste of all the goblets, glasses and dishes standing on the working table, he finally came across one whose contents seemed to possess a remarkably sweet taste. *Thus was made this important discovery.* What remained to be done was accomplished by later researches with this substance. He found very soon that saccharine, as the product was named, when diluted assumed the taste of cane sugar. In watery solution, for instance, its taste was as pleasant as sugar water. The product seemed to be worthy of utilization, provided its other properties were not objectionable.

Physiological experiments were now made on animals, and then on human beings, which showed that it was eliminated undecomposed, and that therefore the human organism behaved indifferently towards the substance. Furthermore, as

no perceptible disturbance of the general condition could be observed, it could be assumed that saccharine had no deleterious influence whatsoever upon the general health.

With the introduction of this artificial sweetener, a new industrial field was opened up, and the significance of this discovery can be easily imagined when you consider that four pounds of this material are equivalent in sweetening power to one ton of cane or beet sugar. It was soon manufactured on such a large scale that it seriously threatened the beet sugar industry of the continent, and as the latter was of much more economic importance than the production of saccharine, laws were enacted which prohibited the industrial use of the sweetener as a substitute for sugar, permitting its employment solely for medical purposes, the German government even going so far as to make a sort of state monopoly of the manufacture of this material.

Still another industry has undergone vast changes through Perkin's discoveries and since the beginning of the coal tar epoch—the manufacture of artificial perfumes. Nitrobenzol, under the name of mirbaneoil, was in the market as artificial oil of bitter almonds even before Perkin's mauve. It was used to some extent for scenting soaps. To-day a great variety of synthetic perfumes are manufactured. The odor of musk is successfully imitated by a nitrated hydrocarbon derived from coal tar; the odor of violets, of roses, of jasmine, of heliotrope, is reproduced artificially by synthetic substances, and the favorite American flavor, the oil of wintergreen, is manufactured from coal tar. And in this art also the hand of the master is seen in what is called the Perkin Reaction, through which he first succeeded in preparing from coal tar, coumarin and cinnamic acid.

The singular correlation of all these coal tar products appears from the fact that the odoriferous principle of jasmine is derived from the same mother substance which furnishes synthetic indigo, namely, anthranilic acid.

Between the products giving the sweet odors of flowers and the death dealing explosives there would seem to be a broad chasm, but not for the synthetic coal tar chemist. In fact the same nitrobenzol which was the first artificial perfume is used to-day with nitroglycerin as a safety explosive. The latter has the disadvantage of congealing when exposed to the cold and then becoming highly dangerous; the admixture of nitrobenzol keeps it liquid at very much lower temperatures. Trinitrobenzol and its homologues, especially trinitrocarbolic acid, or picric acid, are to-day employed as safety explosives by the miner and in proper mixtures as smokeless powder by the armies of the civilized world.

While coal tar preparations thus destroy life, so they likewise sustain life, for by the use of salicylic and benzoic acids, both products of nature but now derived chiefly from this source, it becomes possible to preserve the canned foods so indispensable to the soldier, sailor and explorer.

In conclusion, mention must be made of the use of coal tar colors and preparations in the reproductive arts, in which they play a most important part. Inks for printing and writing are made with coal tar colors and in photography coal tar preparations are now used almost exclusively for the development of the latent pictures on films, plates and paper. By the addition of certain coal tar colors to the photographic emulsion the latter becomes extremely sensitive to light and can then be used for instantaneous exposures, as in snapshots, and thus kodak fiends are the direct offshoots of the coal-tar industry.

By means of coal tar colors even one of the greatest of all problems—photography in natural colors—has been realized.

Curious to relate, with all these successes to its credit, the problem which has occupied the attention of master minds now for almost a century, and which was the incentive of Perkin's research, so fruitful in other fields—the artificial production of quinine—remains unsolved up to the present day.

While thus new arts were constantly developed, the chemical industries, existing at the time of Perkin's discovery, were also eminently benefited. The production of aniline required at once large quantities of sulfuric and nitric acids for the nitration of benzol, and the demand of the new industry for highly concentrated sulfuric acid gave to the world the contact process in which the sulfurous acid gas, formed, for example, in roasting zinc and iron pyrites, which heretofore was allowed to escape and then vitiated the atmosphere and destroyed vegetation, is converted into sulfuric acid by the oxygen of the air. The manufacture of alizarin consumed enormous quantities of caustic soda. Bromine and iodine became staple articles of commerce. The electrolysis of salt solution was economically perfected, and together with the contact process and the liquefaction of chlorine is employed on an immense scale for the synthesis of indigo. The experience gained in electric methods is being applied to the problem of utilizing the nitrogen of the air, and to judge from past successes, it will not be many years before the Badische Anilin and Soda Fabrik, in whose laboratories experiments in this direction are being conducted, will bring to the market nitrates, nitrites and nitric acid made from atmospheric nitrogen, instead of Chile saltpeter, the supply of which is calculated to last no longer than about twenty years, and as Chile saltpeter is indispensable in agriculture, especially in the raising of cereals, its artificial production in the manner indicated will remove the anxiety expressed by writers on economics concerning the difficulties of feeding an ever-increasing population owing to the gradual exhaustion of the soil.

The distillation of coal tar itself was changed in every respect to comply with the new developments. All its by-products are utilized, and one of them, sulfate of ammonia, is produced so economically that it is commonly employed as a fertilizer.

In the cooking processes, of so great importance in the manufacture of iron and steel, the gaseous products are not allowed to go to waste any more, but are recovered and utilized to furnish benzol, etc., in addition to illuminating gas—in fact, the United Coke and Gas Company operates some of its plants in such a manner that the gases are the principal products and coke only a by-product.

In the treatment of these gases, cyanide of potassium is obtained at such low cost that it is used for extracting low class gold ores which hitherto were useless. Hence this substance plays an important part in the monetary system, as its cheap production has disposed of the fear that there would not be enough of the precious metal to maintain the gold standard of the civilized nations.

The chemistry of benzol gave us our modern theories, especially that of Kékulé, which in its application led to marvelous prophesies of experimental results and is recognized to be one of the most remarkable achievements of the human mind.

The coal-tar industry gave us our modern chemical institutes, the wonderful equipments of which were first utilized in the laboratories of the factories, and above all it gave us the intimate cooperation of

technics and science which is in fact at the root of all this magnificent success.

In closing permit me to say that it is unique in the history of civilization that the honor and credit for the creation of this enormous material and spiritual wealth is unanimously and ungrudgingly accorded to Sir William Henry Perkin. It is unique that the creator of this vast industry has been so fortunate as to witness its wonderful development during fifty years. It is unique that when no longer engaged in the industrial part of our science, he undertook a series of theoretical investigations of the utmost difficulty, which only the most gifted have the courage to attempt, and that in this branch, too, he has conquered a position as lofty as his fame as a manufacturing chemist.

The world can not spare such an extraordinary man. May he live for many years to come and may his life be replete with health and happiness.

Hugo Schweitzer.

ADDRESS OF SIR WILLIAM HENRY PERKIN.[1]

It is now twenty-two years since I visited the United States. I was attending the first British Association meeting that was held at Montreal and then extended my visit to Yellowstone Park, returning by Chicago, Washington, Baltimore, Philadelphia, New York and Boston back to Montreal. At that time I certainly never anticipated that in twenty-two years' time I should be in this city at a jubilee celebration of the discovery of mauve and the foundation of the coal tar color industry. It was, indeed, quite unexpected and a matter of surprise to me when I heard that an international celebration was about to be inaugurated in my own country, which took place in July last. This included nations on both sides of the world, as you sent Dr. Baekeland as a delegate to represent America, but it was a still greater surprise to find that you were not satisfied to merely join the English jubilee, but had determined on having a jubilee celebration of your own in this city, which I should be invited to attend. I can only say how greatly honored I feel and how gratified I am at being present here to-night at this banquet, and meeting so many fellow workers in the field of science, and other friends. From the very cordial and friendly reception you have given me, I do not feel at all strange in coming amongst you, especially as I realize how closely we are related to each other by race and language, which naturally engenders a strong feeling of sympathy between us, a feeling which has been so heartily manifested this evening by the warm welcome given by the City of New York, through the Hon. Patrick McGowan, president of the Board of Aldermen, and also in a practical manner by the presentations given by Dr. Nichols, Mr. Kuttroff and Dr. Hillebrand.

The foundation of a medal bearing my name to be annually awarded to an American chemist, I feel to be a great honor, especially as I have all my life insisted on the importance of research work, and if this medal should help to encourage and stimulate some chemists to increased activity in this direction, this jubilee celebration will have accomplished a valuable result. And when we consider the advantages you fortunately have in this country by the existence of a very large research fund, we can not but believe that this will be the case. I thank you very sincerely for presenting me with this beautiful medal, the first that has been struck, which I value very highly.

With respect to the beautiful personal token you have presented to me, I scarcely know how to express myself. I am sure it will always be greatly valued not only by

[1] Given at the banquet tendered to him at Delmonico's, New York City, October 6, 1906.

myself but by Lady Perkin and my family. It has the merit of not only being beautiful but also very useful, and it is a very suitable gift for a total abstainer who is very partial to a cup of tea. Whenever we use it it will remind us of the warm-hearted hospitality which has been shown us in America.

I appreciate very much the honor the American Chemical Society has done in electing me one of its honorary fellows and presenting me with its certificate of membership this evening. I am very pleased, indeed, to have my name associated with this important society, the value of which I gauge from my knowledge of the help the London Chemical Society has been to me, and of which I have this year also completed my jubilee of membership.

I very heartily thank Dr. Nichols, Mr. Kuttroff and Dr. Hillebrand for all their kind and generous remarks in reference to myself when presenting me with these gifts.

That this jubilee should also have another important object in view, namely, the foundation of a reference and circulating library for science, is also a great satisfaction to me, as it may be the means of not only affording useful information to scientific workers, but also of stimulating research.

I am very glad that Professor Chandler is the president to-night. I have known him for a long time, and we must all admire the indomitable perseverance with which he has worked for the cause of chemistry in this city, for now over forty years without flagging. His position as chairman on this occasion is particularly fitting, because of the varied ways in which he has been connected with the coal tar industry, and his acquaintance with the great works in which the colors are made, and I also know the very hearty and active part he has taken in connection with this celebration. I thank him also most sincerely for the kind things he has said in reference to myself.

We have all listened with interest to the remarks of Dr. Schweitzer, who is not only practically connected with the coal tar coloring matters, but has also done good scientific work in connection with them. I thank him also for all the kind references he has made to me. And I take this opportunity of thanking him and all other members of the committee for the pains they have taken to make my visit to this country so extremely pleasant and enjoyable, not only to myself, but also to Lady Perkin and my daughters. It is a landmark in our lives to which we shall always look back with pleasure.

I have no doubt that some of you will have read the particulars of the London celebration and what I said on that occasion, and this makes it difficult for me to address you, and if I repeat much of what I said then, I must claim your indulgence, because one can not but state the things which have occurred in one's lifetime; they can not be varied. As I expect that many of you, however, may not be so well acquainted with the history of the coal tar color industry and the mauve dye which was its starting-point, as people are in the old country, I thought that you might like me to give a brief account of it, especially of its early days, but even to do this is difficult in the time at my disposal, and, moreover, as I shall have to speak about myself, it would have been more agreeable to me if some one else could tell the tale. To begin, it may perhaps first of all interest you to know something of my early days and how I became a chemist.

As long as I can remember, the kind of pursuit I should follow during my life was a subject that occupied my thoughts very much. My father being a builder, the first idea was that I should follow in his footsteps, and I used to watch the carpenters

at work and also tried my hand at carpentering myself. Other things I noticed led me to take an interest in mechanics and engineering, and I used to pore over an old book called the 'Artisan,' which referred to these subjects and also described some of the steam engines then in use, and I tried to make an engine myself and got as far as making the patterns for casting, but I was unable to go any further for want of appliances. I had always been fond of drawing and sometimes copied plans for my father, whose ambition was that I might be an architect. This led me on to painting and made me think I should like to be an artist, and I worked away at oil painting for some time. All these subjects I pursued earnestly and not as amusements, and the information I obtained, though very elementary, was of much value to me afterwards. But when I was between twelve and thirteen years of age a young friend showed me some chemical experiments, and the wonderful power of substances to crystallize in definite forms, and the latter, especially, struck me very much, with the result that I saw there was in chemistry something far beyond the other pursuits with which I had previously been occupied. The possibility also of making new discoveries impressed me very much. My choice was fixed, and I determined if possible to become a chemist, and I immediately commenced to accumulate bottles of chemicals and make experiments. About this time I changed my school and was sent to the City of London School, and to my delight found that lectures on chemistry and natural philosophy were given there twice a week during the dinner interval. These I attended, and not long afterwards the lecturer, seeing the great interest I took in science, made me one of his lecture assistants, my duties being to prepare the experiments, arrange the table and assist at the lectures. This was a great lift to me, and I daily used most of the interval for dinner and not infrequently all, but the abstinence from food this caused did me no harm, as nearly all of us eat far too much. This interval was the only time I had for fitting up apparatus and preparing for these lectures. The lecturer was Mr. Thomas Hall, B.A., one of the class masters, and he was very kind to me and helped me in every way. My father was disappointed at my choice, and the outlook for chemists was, indeed, very poor in those days, and naturally that was a matter that weighed with my father, but Mr. Hall had several interviews with him and eventually I was allowed to follow my bent, and at the age of fifteen I left school and entered the Royal College of Chemistry in London, where Dr. Hofmann was professor.

Under Dr. Hofmann's able instruction I soon got through the ordinary course of qualitative and quantitative analysis and also gas analysis; this I looked upon only as a preliminary part of my chemical acquirements and not, as many used to and some still do, as a full equipment. Research was my ambition and under the professor's guidance this was entered upon and the first investigation completed when I was seventeen. I then became honorary assistant in Dr. Hofmann's research laboratory and helped to carry on his scientific enquiries, and in this way I quickly acquired a considerable insight into the chemical science of that day, as well as experimental experience. My time being much occupied with the professor's work, I had little opportunity of carrying on research on my own account. I, therefore, fitted up part of a room in my father's house and made a rough laboratory, a very different place from the laboratories of the present day. Spirit lamps and charcoal, for combustion, had to be used as sources of heat, as there was no gas. In this labora-

tory work was carried on in the evenings and vacation time. In those days one of the problems was the artificial production of vegetable and animal products, and amongst other subjects I was ambitious enough to try and produce quinine artificially, of course from purely scientific motives, but, as is frequently the case, the research took an unexpected turn; no quinine was formed, but only a dirty reddish-brown precipitate. Unpromising though this result was, I was interested in it and thought it more desirable to experiment with an analogous but more simple material than I had previously used. *Anīline* was, therefore, taken, but in this case I obtained a black and more unpromising product, but on submitting this to investigation found it contained, besides other things, a beautiful purple coloring matter which was found to be capable of dyeing silk and other materials, and it was in fact the product we now know as the 'mauve dye.' This discovery was made in the Easter vacation of 1856. I showed this dye to some of my chemical friends, who thought it might be valuable, but its evident costliness and the difficulties of preparing aniline for its production on a large scale made the probability of its proving of practical value very doubtful. At this time aniline was a very rare product, only found in a few research laboratories, and could not be purchased. Having obtained an introduction to Messrs. Pullar of Perth, the well-known dyers, some pieces of dyed silk were sent to them, and they reported: "*If* your discovery does not make the goods too expensive it is decidedly the most valuable that has come out for a long time." This report was very satisfactory except the *'if'* it commenced with. During the summer vacation, and with the help of my brother, Mr. T. D. Perkin, larger experiments were made and consequently larger quantities of coloring matter obtained, and it was then decided to patent the process, but a difficulty arose. I was but eighteen years of age, and it was questionable whether a patent could be granted to any one under twenty-one (a minor). Counsel's opinion had, therefore, to be obtained, and this was to the effect that, a patent being a gift from the crown, the matter of age did not affect the grant. Further experiments were then made on dyeing and calico printing, and although the colors were admired, that terrible *if* respecting the cost was always brought forward, besides other questions. Nevertheless, I became persuaded in my own mind of the importance of the dye, and as a consequence I gave up my position as assistant to Dr. Hofmann that I might follow up the subject, but at this he was annoyed, probably thinking I was taking a false step. I was also much afraid that by entering into this technical pursuit my research work might be prevented, but I determined that so far as in me lay this should not be the case.

But the difficulty in starting this new industry was that no one was willing to come forward with the requisite capital, because they were not ready to risk it on such a new and untried product as this dye. My father, however, although he had been disappointed at my becoming a chemist instead of an architect, nevertheless, had so much confidence in my judgment that he very nobly risked most of the capital he had accumulated by a life of great industry by building and starting works for the production of this mauve dye. Had it not been for this generosity on his part, for which I have always felt very grateful, probably I should not have been able to start this industry. My father and brother joined me in this undertaking, and I feel that my success was largely due to their collaboration. Time would fail me to enter into all the difficulties that beset the

establishment of this unique industry, not only in having to invent a suitable plant, but also to obtain even the raw material, which was not then made of a definite quality. The processes were quite different in character from those in existing chemical industries. The coloring matter also when made was quite different from ordinary dyes in its properties, and methods for its application as a dye had to be discovered, and this consumed much time. In fact, it was all pioneering work. Nevertheless, the mauve was supplied for silk dyeing as early as December, 1857.

I have mentioned these particulars because the production of this new color and the practical proof of the possibility of manufacturing it commercially was the foundation of the coal tar color industry. When the mauve was seen to be a success, of course every one commenced experimenting with aniline, and three years after its discovery magenta was discovered by M. Verguin in France. None of the difficulties I have mentioned were encountered in the manufacture of this dye; the way was clear and all the processes for the application of the mauve were equally suitable for the magenta, and, moreover, none of the first prejudices in reference to such an innovation as the mauve any longer existed.

Other coloring matters were then discovered by myself and in France by Messrs. Girard and Delaire and then by Dr. Hofmann in England, many of which were derivatives of magenta. These were produced not only in France but largely in England by Messrs. Simpson, Maule and Nicholson; they were also made to some extent in Germany and Switzerland, and very soon dyes of all the colors of the rainbow were obtained from commercial aniline, and the industry made very rapid progress.

In 1868 Graebe and Liebermann commenced an investigation on alizarine, the natural coloring matter of the madder-root, from a purely scientific point of view; this led to the remarkable discovery that this coloring matter is related to a coal-tar product called anthracene, and they also succeeded in producing it from this product. This was the first natural coloring matter which had been produced artificially. Their process, however, was not suitable for the production of this coloring matter technically. Having in my research work studied anthracene and some of its products, I endeavored to find a practical process for the formation of alizarine, and after a time succeeded in finding two suitable methods for its production on the large scale. Caro, Graebe and Liebermann quite independently also discovered one of them. I and my brother then took up its production at our works (my father having died previously), but many difficulties were encountered, one being that of obtaining anthracene, which was not then a commercial product, but after visiting most of the tar works in England and instructing the tar distillers and agreeing to take what they could make, a supply was soon obtained in all different states of purity, which quickly increased. In the meantime the difficulties of the manufacture were overcome and we were soon able to commence supplying alizarine to the turkey-red dyers. Our output rapidly increased, and this artificial coloring matter has now become one of the most important of the coal tar colors and has superseded the natural dye, so that the cultivation of the madder root has practically ceased. In the year 1873 the demand for alizarine had so increased that we felt that it would be necessary to enlarge our works two or three times to meet the demand. My brother and I, however, did not care to undertake this great responsibility; we, therefore, sold our works, hoping our successors would follow up the matter.

This ended my connection with the color

industry from a manufacturing point of view. After this I occupied myself with scientific research, some of which was connected with coal-tar coloring matter, but mostly with other subjects. Some of these are still occupying my attention. But I must not enter into details, as time would fail me.

One of the most remarkable developments of the industry has been the artificial production of indigo, and, curiously, the first process for its manufacture, discovered by Professor v. Baeyer, was dependent for its success on the method of producing cinnamic acid, discovered in my purely scientific investigations, and this dye is now manufactured so cheaply that the cultivation of the indigo plant has been discontinued in many parts of India.

As I mentioned, when I started this industry I was determined not to give up scientific research, and so long as I had to do with it the part I took in its development resulted from the union of industry and scientific research. This has been followed up by others, especially in Germany, and owing to the work of an army of chemists, many of them men of great eminence and most of them engaged in the works and their laboratories, this wonderful development, unequaled in the history of industry, has taken place. This industry has also had a marvelous influence on the development of science itself. Its wonderful growth has also, as a matter of course, created not only directly but indirectly an immense amount of employment for men of all classes, especially the working classes, which can not be gauged, and although America has not become a manufacturing center for the production of these dyes, no doubt many thousands of American workers are engaged in the applications. That this industry which I was permitted to found should have led to this result is a source of pleasure to me, because the final result of our work should be the benefit of mankind.

You have been so good as to honor me by having this jubilee in remembrance of the part I have taken in connection with this coal tar color industry, and whilst I am thankful that I had to do with its foundation and early development, yet I feel that the part I have taken is indeed small when compared with the labors of the army of scientific men and others, both inside and outside the color works, who have advanced it to its present condition. At the same time it is very gratifying to me to receive all the generous and kindly expression of feeling you are manifesting, and I thank you very heartily. But what have I that I have not received? It is not, therefore, for me to boast (and I also feel that I have but imperfectly used my opportunities). I, therefore, can only say in reference to the success which has attended my efforts, Not unto me, O Lord, not unto me, but unto thy great name be all the praise.

REFORM IN MATHEMATICAL INSTRUCTION.

THE principal mathematical reforms recommended by the commission appointed by the Gesellschaft Deutscher Naturforscher und Aerzte is that more emphasis should be laid on the development of the concepts of *function* and *space*.[1] As the commission realized that such fundamental changes are not likely to be accomplished by a mere publication of the results of its deliberations, it appointed two of its members—Professor Klein, of Göttingen, and Professor Chun, of Leipzig—to try to interest secondary teachers in the subject, and, if possible, to bring them to discuss it very freely.

[1] 'Bericht der Unterrichtskommission der Gesellschaft Deutscher Naturforscher und Arzte über ihre bisherige Tätigkeit,' Leipzig, F. C. Vogel, 1905.

The chief aim in this reform is to bring the mathematical instruction in closer touch with applications. Related variables present themselves very frequently in the sciences, and the training in algebra should prepare the student to deal with these concepts in an intelligent manner. More stress should be laid on the study of expressions and less on the analytic transformations and the solution of equations. Graphic representations are especially helpful in the study of the various values of algebraic expressions, and hence these should occupy a more prominent place in algebra. Fortunately, these changes are being effected not only in Germany and France, but, perhaps, in a more rapid manner in England and in America.

The instruction in elementary geometry is at present undergoing the most radical changes, especially in England, which was the last great stronghold of Euclid. The fact that Euclid's 'Elements' remained a standard elementary text-book on geometry for two thousand years reflects less credit on Euclid than disgrace on those who followed him slavishly. During the last few years England has abolished Euclid servitude and her freedom is clearly exhibited in the recent text-books. The 'Manual of Geometry,' by the well-known author, W. D. Eggar, is, perhaps, a somewhat extreme case. In this book there is a chapter describing the vernier, spherometer, callipers and the micrometer screw gauge. It also treats briefly of the mensuration of the simpler geometrical solids, trigonometric ratios, and four-place logarithms.

In France the 'Nouveaux éléments de géométrie' by C. Meray has, perhaps, been the most effective in producing a decided advance. In this work the plane and the solid geometry are not separated, the concepts parallelism and perpendicularity are established by means of translations and rotations, and the theorems relating to the congruence of triangles are developed later than is customary in the classical works. At a recent meeting of the French Association for the Advancement of Science a resolution was passed requesting the minister of public instruction to assist in securing a more general adoption of these methods in the text-books.

While we may not be able to foretell what the elementary geometry of the next decade will be, yet it seems probable that philosophy will largely give way to observation, the abstract to the concrete, the rigor which appeals to the scholar to the elementary methods leading to a clearer understanding of our physical surroundings. In view of the fact that England was the last one of the great nations to abandon Euclid, it seems likely that she will soon produce the best text-books in elementary geometry, for she is in a position to profit by the experience of the nations which made the transition at an earlier period.

There are two subjects whose elements should constitute a part of a regular course in elementary geometry, viz., analytic geometry and vector analysis. These open up such wide fields and are of such an elementary character that the average student would enjoy their study much more than the proof that two right angles are equal or that one side of a triangle is less than the sum of the other two. Moreover, both vector analysis and analytic geometry furnish simpler and more direct proofs of many theorems than the ordinary methods of elementary geometry and it seems poor policy to teach the poorer methods first.

The increasing use of graphic methods both in algebra and in the other sciences calls for a much earlier study of the elements of analytic geometry, and the enormous progress of physics calls for an early

acquaintance with such a strong tool as vector analysis. Moreover, a vector has so many physical applications that the line representing it becomes full of meaning to the student, and geometric constructions thus admit of interpretations which escape the notice of the student whose geometrical training has proceeded along the old lines.

The plea for an early introduction of the methods of analytic geometry has historical support since the 'Tractatus de latitudinibus formarum' of Oresme was popular during the period of the early development of European universities when very little of Euclid's 'Elements' were taught and the mental advancement of the students was low. The graphic representation of a function upon which so much stress has been laid in recent years was relatively farther advanced in these early days than it is at the present time. The thought of direct usefulness is again assuming a more dominating influence in early mathematical instruction. We are laying more stress upon the student's ability to use a theorem intelligently than upon his giving a faultless demonstration. In fact, a prominent Harvard professor is said to have told his students that the demonstration of a theorem is no evidence that it is understood, but the intelligent use of the theorem constitutes such evidence.

A fundamental aim in early education is to give the student a clear comprehension of the world in which he lives and to furnish him with the necessary knowledge to make a wise use of his faculties. In view of the fact that the sciences and their applications are continually playing a more prominent rôle in the civilized world and that international relations are becoming more and more important, it becomes necessary to readjust the machinery of education from time to time. Many of the necessary changes should be regarded as steps towards a proper readjustment rather than as fundamental progress. In view of the great conservatism in mathematics the readjustment along this line is apt to be slow and to require unusual perseverance.

When such strong men as Klein, of Germany, Forsyth and Sir Oliver Lodge, of England, Moore and Fiske, of America, take active part in reform movements they are certain to be effective. The discussions in Germany in recent years have been so active that Gutzmer describes them as stormy at times.[2] In France the discussions have received less attention, but there has been a decided movement towards graphic methods and especially towards the early use of the differential and integral calculus. In England Professor John Perry, of the Royal College of Science in London, has probably done the most radical and effective work, so that the reform movement is sometimes known as the 'Perry movement.'

While these tendencies in elementary mathematics have some influence on mathematical instruction in the universities, yet they do not affect this work nearly so much as the elective system in secondary education. In view of the diversity of the courses pursued by students before entering the universities, the departments where the work has to proceed step by step, as in mathematics, are compelled either to make provision for more elementary courses or to exclude a large number of students. This difficulty exists not only in our institutions but also abroad, and Klein, for instance, urges that the universities should meet the difficulty by offering a greater variety of courses. He discourages the efforts on the part of friends of the real gymnasium who have tried to abolish some elementary courses in languages at the universities with a view to securing a more general

[2] Jahresbericht der Deutschen Mathematiker Vereinigung, Vol. 13, p. 517.

recognition of the equality of their courses to those of the older gymnasium.

A fundamental tendency in the early university instruction is towards a closer coordination with applications. In a less marked degree the coordination of the various mathematical subjects has been considered. The latter seems wise, as reforms should begin at home. Before considering the closer union of mathematics and physics, for instance, it might be well to consider whether the water-tight compartments of the various mathematical subjects are not doing more mischief than those between the various departments. While mathematics should be taught with a view to helpfulness to other departments, yet its first duty is to help itself and to secure its own harmonious development. A starveling can not render strong service to others.

G. A. Miller.

University of Illinois.

SCIENTIFIC BOOKS.

California Mammals. By Frank Stephens. Illustrated by W. J. Fenn from studies in the field. Published by the West Coast Publishing Co., San Diego, California, 1906. 8vo, pp. 352, frontispiece, 6 half-tone plates, 40 illustrations in the text, and a faunal map.

'California Mammals,' by Mr. Stephens, is noteworthy as being the first recent local 'handbook' of the mammals of any part of North America, and fortunately sets a fairly good standard for the many similar much-needed local manuals of our mammals that we hope may speedily follow. The scope of the work is "California and that part of the Pacific Ocean properly belonging to California. All the mammals described are known to have been found within the state or within sight of its shores." The number of species and subspecies treated is 276—a surprisingly large number, yet readily explained by the great latitudinal extent of the state, and its extremely diversified character, ranging from the subtropical desert areas of the southeastern part to the subarctic snow-covered summits of the Sierra Nevada.

Although diagnoses of the higher groups, from class to genus, are given, the work is written as far as practicable in non-technical phraseology, but for the convenience of such readers as may not be familiar with some of the terms necessarily employed, a three-page glossary is supplied. Mr. Stephens is well equipped for his work, having had a long field experience as a natural history collector in California, and is thus able to give the ranges of the species and subspecies, particularly of the southern two-thirds of the state, largely from his own personal knowledge. The descriptions of the forms are brief, but for the most part give all there is to say. These are followed by a statement of the type locality and range, and by a few lines to several pages of original biographical matter, according to the circumstances of the case. There is no synonymy, nor any bibliographical references, but the life histories are an important contribution. The illustrations are not numerous, and relate wholly to external features. Good figures of skulls of a considerable number of genera would have been a valuable addition; an extended bibliography was obviously beyond the scope of the work, but a list of titles of the principal papers relating to California mammals would have been useful. The book had to have its limitations, and for a work so well done as is this, and containing so much that is convenient and valuable, it is perhaps hardly fair to make suggestions that the author, perhaps, considered and found impracticable of execution. There is only one thing to say in the matter of serious criticism, and that is that the work is worthy of better typographical execution. The text, as to matter and style, is excellent, but the proofreading is unfortunately defective.

The work is intended for 'beginners' and not for experts, yet it is doubtless equally welcome to both, and for the first class it has been put together with excellent judgment. For many of the subspecies, especially in certain groups, it is almost impossible to give

any characters by which they can be distinguished from their next of kin. The differences are merely comparative and often intangible, and the author kindly warns his readers that they can not hope to satisfactorily discriminate between them; and that when certain groups 'are critically studied as a whole,' as in the case of *Thomomys*, a considerable number of them 'will probably be dropped.' Under coyotes, of which three *species* are credited to California, he says: "Little harm would be done if all the California coyotes were grouped together under the name [*Canis*] *ochropus*. * * * Those not experts will find it difficult to determine the species of coyotes."

Following the main text is a chapter on 'Life Areas in California' (pp. 283–291), illustrated with a map, on which are indicated the seventeen faunal divisions the author has found it desirable to recognize. This is followed by a 'List of California Mammals and their Faunal Distribution,' which is noted by means of references to the map. A glossary and a very full index (40 pages) close the volume.

J. A. ALLEN.

Physiology of the Nervous System. By J. P. MORAT, of the University of Lyons. Authorized English edition, translated and edited by H. W. SYERS, M.A., M.D. (Cantab.), Physician to the Great Northern Central Hospital. With 263 illustrations (66 in colors). Chicago, W. T. Keener & Co. 1906. Pp. xxviii + 680.

This work, a portion of the 'Treatise on Physiology' by Professors Morat and Doyon, is a full and systematic exposition of the physiology of the nervous system. The subject has been treated with great clearness and conciseness. The elementary nervous functions, including the anatomy and functions of the neuron in general, the methods of using electricity in the study of nerve actions and the effects of nerve poisons, are discussed in the first part. The individuality of the neuron is brought out as the essential point in the theory of the nervous element without entering into a technical discussion on the *continuity* or the *contiguity* of the articulated prolongations of these neurons. With reference to the question of nervous amœbism, as with other mooted points which at the present time only lead to fruitless discussion, the author takes a neutral stand. The laws of Waller, in modified form, are described in a clear manner. The views of Bethe, opposed to the Wallerian idea of the regeneration of the peripheral stump of the severed nerve, are not discussed, perhaps, to the advantage of the lucid presentation of the general laws of nerve degeneration. Death by electricity is discussed in the light of recent experiments on animals and of accidents arising in industrial applications of high-tension electrical currents.

The systematic functions, *i. e.*, the functions which originate in the associations and definite relationships which are established between the cellular functions, are discussed in the second part of this work. The relationships of sensation and motion are defined very concisely. In introducing this important chapter the author tersely says:

> Except for the infinitesimal part which each one of us plays therein a knowledge of the living world is based on anthropomorphic reasoning, and it is impossible to base it on any other reasoning.
>
> Hence it is necessary to exert great prudence in employing it.

This part contains sub-chapters on the metamerism of the spinal nerves; and their functions, and the fundamental determinations of the cranial nerves. The pneumogastric and trigeminal nerves are very thoroughly treated. The chorda tympani is regarded, together with the two superficial petrosal nerves, as the principal continuation of the nerve of Wrisberg (nervus intermedius). In the second chapter the reflexes, conscious, sub-conscious and unconscious, are classified and described extensively. The author avoids attempting to explain the mechanism of inhibition, but indicates by comparisons how this phenomenon belongs to the category of explicable facts of which the explanation itself is wanting.

The most noteworthy and interesting por-

tion of the work treats of the superior systematizations of the brain, comprising visual, auditory, tactile, olfactory and gustatory innervations. The chapter on language and ideation, together with the cerebral localizations of language and of the aphasias is particularly noteworthy. The phenomena of sleep, hypnotism, dissociations of personality, spiritualism and other topics belonging to the borderland between physiology and psychology are briefly defined in terms of physiological functions.

The work embodies the latest real advances in our knowledge of the nervous system without being burdened by superfluous references to trivial points of controversy. Each chapter is followed by a fairly extensive classified bibliography and the translator's work is practically faultless. The illustrations have been selected with care and are neither too few nor too many in number. The work will surely commend itself to both the physiologist and the practical neurologist.

Edw. Anthony Spitzka.

SCIENTIFIC JOURNALS AND ARTICLES.

The July number (volume 7, number 3) of the *Transactions of the American Mathematical Society* contains the following papers:

M. Mason: 'On the boundary value problems of linear ordinary differential equations of second order.'

M. W. Haskell: 'The resolution of any collineation into perspective reflections.'

L. E. Dickson: 'Linear algebras in which division is always uniquely possible.'

J. E. Wright: 'Correspondences and the theory of groups.'

E. Kasner: 'The trajectories of dynamics.'

R. Morris: 'On the automorphic functions of the group $(0, 3; l_1, l_2, l_3)$.'

R. G. D. Richardson: 'Improper multiple integrals.'

The opening (October) number of volume 13 of the *Bulletin of the American Mathematical Society* contains the following articles: 'Criteria for the Irreducibility of Functions in a Finite Field,' by L. E. Dickson; 'On the Theory of Equations in a Modular Field,' by L. E. Dickson; 'Notes on the Variation of the Definite Integral,' by N. J. Lennes; 'A Note on Transitive Groups,' by W. A. Manning; 'Differential Geometry of n Dimensional Space' (Review of Guichard's Systèmes triplement indéterminés et Systèmes triple-orthogonaux), by L. P. Eisenhart; Shorter Notices (Macfarlane's Bibliography of Quaternions and Allied Systems of Mathematics, by H. E. Hawkes; Echol's Elementary Text-book on the Differential and Integral Calculus, by M. W. Haskell; Cattell's American Men of Science, a Biographical Directory, by G. A. Miller); Notes; New Publications.

The American Naturalist for September contains the following articles: 'Histogenesis of the Retina,' by A. W. Weysse and W. S. Burgess; 'Notes on Marine Copepoda of Rhode Island,' by L. W. Williams; and 'Lichens of Mount Monadnock, New Hampshire,' R. H. Howe, Jr. The first paper is based on a study of the retina in the chick, is fully illustrated, and shows, among other things, that there is a large amount of individual variation in the rate of development of the retina as a whole, and also of its component parts. Mr. Williams, in his paper, records twenty-six species of copepods, three of which are described as new. Mr. Howe records no less than seventy-one species of lichens from Mt. Monadnock.

The Museums Journal of Great Britain for August contains an abstract of the Bristol meeting and a detailed history of the Bristol Museum and Art Gallery, by Ald. W. R. Barker. The next meeting of the association will be held at Dundee.

DISCUSSION AND CORRESPONDENCE.

CATS AS PLANT INVESTIGATORS.

It has taken half a lifetime for Americans to discover the delicious qualities of the pomelo, but it has taken the cats of Boston only six months to appreciate a new cat delicacy.

Professor Sargent, of the Arnold Arboretum, near Boston, imported from Central China a new vine, only a few plants of which were securable. As the species (*Actinidia po'y-*

gama) was a rare one and had never before been introduced into this country, the plants were put in the greenhouse and carefully watched, but before they had made much growth the propagator, Mr. Dawson, observed that some animal was eating their tender shoots. There were no rats, as a cat was kept constantly about and Mr. Dawson was puzzled to discover what new kind of pest he had in his greenhouse. The thought that the damage was done by cats never occurred to him, until, after the plants were severely injured, when he discovered some cat hairs on the half-eaten branches, and, watching more closely, he caught the hothouse cat eating not only the small tender shoots, but the large woody twigs as well.

In the spring he set out over a hundred small vines in a cold frame but, to his surprise, after removing the protection which the sash afforded, the cats of the neighborhood destroyed the whole bed, eating the plants to the ground. They were not just nibbled, as are catnip or valerian, the only other plants known to be eaten by cats, they were completely destroyed—gobbled up—even to stalks as big as a lead pencil.

No place in the arboretum is now concealed enough to be safe from ravage, and the few two-year-old vines in it are completely protected by wire nettings. Every leaf or twig on these caged vines which is near enough the wires to be within reach of claws is scratched and torn to bits. In a few months time this entirely new plant from the interior of China has become the most relished vegetable which our American cats have ever tasted.

The plant has no odor that we can detect, neither has it any distinct taste. Did the cats scent it, or do cats, which are carnivorous animals, make a practise of tasting every new plant that comes within their ken? If they do, they certainly excel in investigative faculties the most civilized races of human beings. Then too, how did the news spread so that in a few months after its introduction all the cats of the neighborhood knew of it? Did the greenhouse cat communicate his discoveries to his friends, or did each cat make the test independently?

The whole story throws an interesting sidelight on cat instinct and intelligence and starts a score of questions. It is difficult to see how there can be here an instinct inherited through long generations of ancestry, for the plant has been unknown in Europe and America until a few years ago. It seems to show an alertness of cat intellect which is most remarkable and which is in sharp contrast with the reluctance of the average human being to taste new things.

DAVID FAIRCHILD,
Agricultural Explorer.
DEPARTMENT OF AGRICULTURE.

SPECIAL ARTICLES.

EVIDENCES OF SEVERAL GLACIAL AND INTERGLACIAL STAGES IN NORTHEASTERN NEW ENGLAND.[1]

WHILE conducting an investigation of the underground water resources of northeastern New England during the present field season, the writer has had occasion to visit many parts of northeastern Massachusetts, southeastern New Hampshire and southern Maine, and has incidentally noticed numerous cuts and exposures which throw light on the differentiation of drift in this long-neglected section of the country. There seems to be no longer any doubt that in northern New England, as elsewhere, there have been at least three distinct ice advances, separated by interglacial stages; and when more evidence has been obtained it will probably be possible to definitely correlate them with those of southern New England.

The writer hopes in the near future to publish a detailed account of his observations and conclusions. In the meantime a brief statement of the formations observed and their possible correlations with deposits in other sections may be of some interest.

1. *Pre-Pleistocene (Probably Tertiary) Clays.*—A deep boring made in Boston in 1905 penetrated over 100 feet of a fine light gray to white, very pure clay, underlying all glacial deposits. This clay appears to be of

[1] Published by permission of the director of the U. S. Geological Survey.

pre-Pleistocene age and later than the Carboniferous bed-rock of the region. Similar deposits are reported in borings elsewhere in Boston and were noted by Crosby in his report to the Committee on the Charles River Dam. Samples of this clay from the boring mentioned above were examined by the writer in the office and compared with specimens of various Quaternary, Tertiary and Cretaceous clays, and were found to be almost identical in appearance with much of the Cretaceous clay from borings on Long Island described by Veatch and called by him Raritan.

2. *Unconformity.*

3. *Very Ancient Till.*—This was observed at Lawrence and Haverhill, Massachusetts, at Norridgewock, Maine, and at a few other localities. It is composed of a larger percentage of local material than are the common tills of the region, is deeply oxidized, of a brighter yellow color, and very rotten. A few rounded pebbles of quartzite and similar durable rocks are contained in it, but no granitic or diabasic rocks could be found. These deposits are believed to correspond in age to the old tills described by Fuller in southeastern Massachusetts, with the Mannetto gravels described by Fuller and Veatch on Long Island and elsewhere and with the Kansan or the pre-Kansan till of the middle west.

4. *Unconformity.*

5. *Stratified Fossiliferous Clays.*—Small exposures of these beds underlie drumlins at Winthrop and Revere, Massachusetts, and the material derived from the clays, with its contained fossils, is incorporated in the drumlins of Boston Harbor. The deposits have been correlated by Fuller with the Gardiner clay of Long Island and Cape Cod. Local clays which are possibly of this age have been observed in Maine.

6. *A Thick Deposit of Till.*—This is the principal till sheet of New England, including hardpan deposits of sand, gravel, clay and bowlders, often of great thickness, covering all older formations. It includes the drumlins of Massachusetts and New Hampshire. Where it has not been eroded this till is yellowish from the effects of oxidation to a depth of five to fifteen feet. Until recently it has been considered of Wisconsin age, but Fuller has lately thrown it into the Illinoisan, correlating it with the Montauk of Long Island. The evidence collected this summer of a more recent till, confirms this correlation.

7. *A Great Thickness of Coarse Gravels.*—These are well developed in the Kennebec, Androscoggin and Penobscot valleys, and their relations are perhaps best exposed in the vicinity of Augusta, where they may be seen resting on (6) and overlain by (9) and (10). They were deeply eroded before the deposition of overlying deposits. These gravels may be equivalent to the gravels described by Fuller as overlying the Montauk till on Long Island, etc.

8. *Unconformity.*

9. *Fossiliferous, Stratified, Blue-Clay ("Leda-Clay" of Jackson, Hitchcock, Packard and others).*—This is an extensive deposit, rising from about twenty feet above tide in the vicinity of Boston, to over 200 feet in the Kennebec and Androscoggin valleys and found throughout the coast region and larger valleys between Boston and Eastport. This clay is well stratified, frequently fossiliferous, and is deeply oxidized. It is occasionally folded and contorted and often overlain by sand deposits and generally by till. Fossils, where found, most often occur near the bottom of the clay beds, and stones are most frequent in the upper part. The folding and unconformity can be observed at Saugus and Haverhill, Massachusetts; at Portland and Augusta, Maine, and elsewhere. The presence of till both above and below the clay places it most probably in the interval between the Illinoisan and Wisconsin glaciations, and it may have been deposited at about the same time as the Iowan loess, to which its relations are rather similar.

10. Overlying the clay in some localities are a few feet of stratified sands, rising to the same general level as the clay, probably being a part of the same series. These, together with some of the Wisconsin sands, were called 'Saxicava sands' by the early geologists.

11. *Unconformity.*

12. *A Few Feet of Till.*—This till generally occurs as a thin deposit three to ten feet in thickness, but occasionally seems to be thickened up in the form of drumlin-like deposits amounting to as much as fifty feet. It is generally more gravelly than the Montauk type of till, and the oxidation does not often extend over three to five feet from its surface. This till can be seen resting on clays and gravels throughout this part of New England, but the best section is probably in the vicinity of Augusta. This till is believed to be the true Wisconsin till of New England.

13. *Retreatal Deposits of Sand, Gravel and Local Clays.*—These occur over wide areas in Massachusetts, New Hampshire and southern Maine. They were formed in part in glacial lakes and in part as outwash deposits in the sea or above water level.

14. *Deposits of Local Glaciers.*—In several localities in Maine: (*a*) In the territory directly east and southeast of Mt. Katahdin in northern Penobscot County, (*b*) in the mountainous region between Bangor and Ellsworth in Hancock County, and (*c*) in southern Piscataquis County, there is considerable evidence from direction of striæ, amount of oxidation, position of moraines, etc., indicating probable local glaciations somewhat later than the Wisconsin ice advance.

In closing this abstract the writer wishes to acknowledge his indebtedness to Mr. G. C. Matson, who assisted him in the underground water investigations and obtained many data helping towards a solution of Pleistocene problems.

FREDERICK G. CLAPP.
UNITED STATES GEOLOGICAL SURVEY.

CURRENT NOTES ON METEOROLOGY.

THE FIRE-SHIP OF BAY CHALEUR.

IN his 'Notes on the Natural History and Physiography of New Brunswick' (*Bull. Nat. Hist. Soc. New Brunswick,* xxiv, Vol. V., 1905) Professor W. F. Ganong has a short paper, 'On the Fact Basis of the Fire (or Phantom) Ship of Bay Chaleur.' After an examination of all the evidence it appears to the author plain (1) that a physical light is frequently seen over the waters of Bay Chaleur and its vicinity; (2) that it occurs at all seasons, or at least in winter and summer; (3) that it usually precedes a storm; (4) "that its usual form is roughly hemispherical with the flat side to the water, and that at times it simply glows without much change of form, but that at other times it rises into slender moving columns, giving rise to an appearance capable of interpretation as the flaming rigging of a ship, its vibrating and dancing movements increasing the illusion." This is doubtless a manifestation of *St. Elmo's Fire,* but the compiler of these notes is not aware of any reports of similar phenomena, of such frequency in one locality, and of such considerable development. Professor Ganong cites the case of some lights reported around Tremadoc Bay in Wales, but notes that they in all probability had only a subjective basis. Lights of unexplained origin, the author notes, were reported as common off the Welsh coast two hundred years ago, and mention is made of St. Elmo's Fire observed at Anticosti. The phenomenon described by Professor Ganong is an interesting one, well worthy of careful study.

MONTHLY WEATHER REVIEW.

The Monthly Weather Review (No. 5, 1906) contains the following papers of general interest: 'Present-Day Climates in their Time Relation,' by F. M. Ball, of the University of Minnesota, a brief review of some of the more important facts regarding climatic changes, with the emphasis on geological changes. 'Severe Hailstorm in the Gulf of Mexico,' reported by R. G. Bindley, officer of the S. S. *Jamaican.* This storm occurred on March 18 last; the hail was so heavy that the ship was stopped and the officer of the watch and the helmsman were compelled to seek shelter. The first officer received a severe bruise caused by a hailstone striking the back of his neck, and the helmsman received a scalp wound. The stones dented the binnacles and chipped paint off rails and other painted surfaces. 'Tornado in Australia,' an account based on notes by H. A. Hunt, government meteorologist of New South Wales. This tornado was

a mild form of the American phenomenon of the same name. It occurred at North Sydney, March 27 last, in the region of northeast cyclonic winds, and moved southeast. This is the region which corresponds to the usual part of a cyclonic area in which our tornadoes occur.

BÖRNSTEIN'S 'LEITFADEN DER WETTERKUNDE.'

ONE of the most useful text-books of recent years is Börnstein's 'Leitfaden der Wetterkunde,' the first edition of which was published in 1901. This excellent little volume has now come to a second edition (Berlin, 1906), and has been brought thoroughly up to date. It in no way trespasses on the ground covered by any other of the newer text-books, and is unique in presenting an extraordinary richness of material, in a clear, compact form, with an admirable list of references to publications where further details may be sought. In the new edition special attention is paid to the temperature conditions and movements of the upper air, and to other subjects upon which recent studies have thrown much light. We note an interesting view (Fig. 14) of the upper surface of a sea of clouds, in which the course of underlying rivers is indicated by breaks; the inclusion of Berson's excellent classification of the different atmospheric strata in relation to vertical temperature gradients (p. 35); and the beautiful colored cloud views, Pls. V.–XV.

THE CYCLONIC THEORY.

W. H. DINES, who has been active in the prosecution of kite meteorology, says (*Nature*, 1906, 35–36) that the results of some two hundred kite ascents which he has carried out in England and Scotland, with an average height of about one mile, seem to give no evidence either for or against the convectional or 'driven' theory of cyclones. Dines believes that an error has been made in working out the results of free-air observations in cyclones and anticyclones. In a gas in equilibrium, he says, under a conservative system of forces, the isothermal and isobaric surfaces must be identical. The temperatures in cyclones and anticyclones should, therefore, not be compared at the same height, but on the same isobaric surfaces. In temperate latitudes these surfaces may differ from surfaces of equal height above sea level by a thousand or more feet.

'SOME FACTS ABOUT THE WEATHER.'

UNDER the above title, Mr. William Marriott, assistant secretary of the Royal Meteorological Society (London), has published a little handbook of thirty-two octavo pages, at the price of sixpence (London, Stanford, 1906). The text covers about the ground of a 'popular' lecture on meteorology, but is especially adapted for use in the British Isles.

R. DEC. WARD.

YALE UNIVERSITY.[1]

OUR constant growth in numbers and our recent increase in endowment ought to enable us to do better work in the future than we have done in the past. A progressive university should make the maintenance and improvement of its standards its chief concern. It must be recognized as a place where truth is discovered and taught. I propose to discuss some of the means by which we can reach this end.

In dealing with the question of university organization, we can divide our members into three groups: (1) heads of departments; (2) other instructors and graduate students; (3) undergraduates in the various courses, liberal or professional. This is not the conventional line of division, but it is the one which best serves our present purpose.

Heads of departments ought to be fewer in number, and better paid. This is probably true of American universities as a class; it is certainly true of Yale. We have too many full professors, and, partly as a consequence of this, we pay them too small salaries. If we see a store or factory where there are a large number of more or less separate departments whose heads receive low salaries, we believe that the business is being wrongly administered. It is not always safe to draw too close analogies between industrial work and

[1] From the report of President Hadley.

educational work, but in this case I believe the parallel holds good.

The first step toward reform is to recognize the principle that no man should be appointed to a full professorship in any subject merely because that subject needs to be taught. If there is a man of eminence in the subject who has a genius for discovery or teaching, the fact that such a gap exists creates an additional reason for calling this man to a professorship. But if no such man is to be found the place should be filled by an assistant professor. The fact that we have departed from this principle in the past, and now have on our faculties as full professors a number of men who ought to be only assistant professors, does not alter the necessity for a change of policy in this respect. I am glad to say that nearly all the members of the several faculties of the university cordially accept the principle here laid down, and are willing to try in future to appoint none but a first-class man to a grade higher than an assistant professor, even though this policy may for the moment apparently weaken the strength of our teaching force. This weakening will be apparent rather than real. There is nothing which really weakens the teaching force so much as the permanent appointment of a man of the wrong type, who lowers the standard held before the students and blocks promotion among the younger instructors. It is far better to have a subject taught by ambitious young men who see an opening ahead than by a somewhat older man who has little to recommend him except his maturity.

With the diminution of numbers, an increase of salaries can follow as a matter of course. This process has already begun, and many of the professors who have hitherto received $3,750 are now to receive $4,000. But this should be regarded as only a beginning. Just as soon as the university finances admit it, there should be a further increase to $4,500, and then to $5,000 or even $6,000. There should also be an increase in the number of assistants, who can relieve the professor of the burdensome necessity of reading papers or directing some of the details of individual study. If a professor is really able and mature, the ideal method is not to give him a division of forty or fifty or sixty, as we used to, with a class-room which would be partly examination and partly lecture, but to let him talk all at once to as many students as possible, be it two hundred or five hundred; and then have these men met as often as once a week in very small groups by a younger instructor, who can talk over the work that they are doing and examine the progress that they are making. Both here and at Harvard this scheme has increased both the teaching efficiency and the financial economy.

We must, however, guard ourselves against the danger of creating a separate or privileged class of research professors. In some universities there is a tendency to set some men apart for discovering new truth, while employing other men to teach old truth. This is a mistaken policy. We are not dealing with an ordinary case of division of labor. The chief argument for division of labor is that it makes each man more expert and more efficient in his own field of work. In university work, however, the man who tries to investigate without teaching is apt to become sterile, while the man who attempts to teach without investigating becomes a worse teacher instead of a better one. We want the opportunities for research and investigation distributed as widely as possible throughout the teaching force and the student body. We want to impress upon every man that teaching and discovery are both done at their best when done in combination. Not that every man should be compelled to lecture to classes, whether he is able to do so or not. There is a great deal of valuable teaching which is not done in the class-room, or even in the laboratory. There are some men who teach best by their writings, their conversations, their intelligent suggestions for the work of others; but they should understand that they are part of the teaching force, and are simply doing their teaching in a different way from other men. Instead of setting such a man apart as a research professor, we should let him understand that withdrawal from the lecture room and relief from the

duties of supervising elementary students carry with them a larger obligation to publish as fully as possible the results of all discoveries; to organize departments intelligently; to train up young men who can teach; and to make liberal room for such men, instead of trying to get in their way when their work becomes popular.

These last statements indicate the policy which we should adopt in dealing with our junior instructors and graduate students. We should give them the maximum of freedom consistent with their teaching duties. We can not, under the existing circumstances, pay them as large salaries as we should like to do, or as the work of many of them deserves; but we can at least give them a fuller chance to show what they have in them. In the time which is necessarily occupied by class-room work we can allow them more independence of method than has been habitual in the past. If we have as heads of departments men who are competent to look after results we can leave their assistants the utmost freedom in the choice of means. We can make a university a good place for an instructor or student of any grade who thinks that he has something to discover. If we keep places free at the top we increase his opportunity for promotion if his discoveries turn out as he expects; and if promotion does not come here we can always find chances for him elsewhere. Of course there will be among the members of the teaching force many a man who disappoints us, and perhaps disappoints himself; but if one of his superiors—president, dean or head professor—gives him timely warning that we shall not be able to promote him here, it is easy to find such a man a teaching place elsewhere without grave hardship to him and with definite advantage to the university.

The success of a system of this kind is to some degree dependent upon the laboratories and library facilities accessible to the different instructors. But a laboratory or library of moderate size, administered in the right spirit, is far more efficient than a much larger one which is monopolized by a few heads of departments for their own special investigations. It is astonishing what an amount can be done with very moderate facilities by a group of young men working together, animated by the spirit of independent investigation for the moment and by the prospect of distinction for the future. In each new laboratory that we establish, or in each new appointment to the headship of an old laboratory, we set forth clearly the fact that it is to be open to the use of junior instructors and graduate students just as far as the circumstances allow, to work in the way that they think promising rather than in the way that the chief thinks promising. This will result in a good many mistakes, and in some waste which might have been avoided; but it will result in vastly increased efficiency and in a great many discoveries which would otherwise have been prevented.

Mr. Schwab, in his position as head of the library, is fully in sympathy with these ideas; and the addition to the library building, erected from the bequest of William B. Ross, as a memorial to Jared Linsly, is being arranged with that end in view. There is no other institution connected with the university whose administration affects the efficiency of so many departments. Yale is to be congratulated on what Mr. Schwab is accomplishing and also upon the care and intelligence shown by Mr. Haight, the architect of the new building, in enabling us to achieve the most with the means at our disposal.

A committee of the university council is arranging plans for increased opportunities for publication of new discoveries in various lines—a matter in which during recent years our facilities have been inadequate. This is a thing of great importance as a stimulus to the older students and younger instructors. The full professors have so much reputation that they can publish their work anywhere, and proper attention will be given to it; but for the men who still have their reputation to make, the opportunity for a convenient and quick channel of publication is a great stimulus to the work and a great help to the university with which their published work is identified. Nothing in times past did more

for the development of the scientific spirit at Yale than the fact that Silliman's *Journal of Science,* for many years the one high grade American periodical of its kind, was published here. In other lines we have not kept up to the traditions set by Professor Silliman, and have suffered from it rather severely; but it is by no means too late for recovery.

The independence of the different faculties at Yale is in some respects a help, and in other respects a hindrance, to our investigators. It is a help in that it helps to keep alive the traditions of academic freedom. It is a hindrance in that it sometimes prevents the most effective cooperation between the laboratories of different departments.

A thing which is an unmixed help in every way, and should not be overlooked in any discussion of Yale's advantages, is the Graduates' Club. By furnishing a center in which instructors and students of all grades and visitors from abroad meet informally on a plane of social equality, it tends to diffuse the spirit of academic freedom and academic progress. It adds immensely to the attractiveness of New Haven as a place for the ambitious investigator, be he student or instructor, and does more than any other one thing to help the formation of that indefinable thing called a university atmosphere. The Graduates' Club was not organized with this end in view. If it had been, it probably could not have accomplished the result so effectively.

SCIENTIFIC RESEARCH.[1]

A COLLEGE, as the word is usually understood in America, is a school of general training. Its work is found to be the more effective the better it is fitted to the traits of the individual, but in the nature of things its work with the individual is not limited to a narrow range of subjects. The university is a school of instruction through investigation. Its characteristics are advanced research and specialized development. As matters are, the faculty of the American university has to deal with two sets of students and two classes of instruction, those of the college and those of the university. But in both cases it is for the university to set the standard. To the university teacher, individual research is the breath of life, and it is the duty of the institution in every reasonable way to foster its development.

In the practical consideration of this problem we may take the following propositions as granted:

1. A few men, and but a few, even in the greatest universities, ever contribute very much to the direct advancement of science.

2. No one can be a great teacher without the spirit of research; without this he lags behind the progress of knowledge, and his mental equipment becomes second-hand.

3. With most men the practical purpose of research is that they may be better teachers.

4. With most men a reasonable following of students is an aid to research, not a hindrance.

5. Those who feel called to research, but who can not or will not teach, should in general look outside the university for careers, at least until they have clearly proved their eminence.

6. The university should recognize the superior teacher or investigator by relieving him, as far as may be, of administrative drudgery, which uses up time and strength more than teaching does. Every active worker should have what he needs in the way of help of stenographers, artists, readers, curators, mechanics and the like. A man of choice powers should not waste his time on what cheap men can do. It is often best to relieve the ablest men in the department from its executive responsibility.

7. It is desirable that a university should publish the results of completed investigations of its professors, and do this in first-class form. Such publication in worthy manner is a stimulus to good work. But material brought together under stress of demand for publication is best left unprinted.

[1] From the annual report of President David Starr Jordan, Stanford University.

A MEMORIAL TO HERBERT SPENCER.[1]

A SHORT time ago a petition was presented to the Dean of Westminster asking permission

[1] From *Nature.*

to place in Westminster Abbey a memorial tablet commemorating the life and influence of Mr. Herbert Spencer, but though the appeal was supported by many men of science and letters it was rejected. The reason why the Dean withheld his consent to this unobtrusive memorial of a great philosopher is not clear; and the *Daily Chronicle* has recently revived interest in the movement with the object of inducing him to reconsider his decision, or, failing this, to secure some other national memorial of Spencer's work. From the opinions of a number of distinguished men published in our contemporary, it is evident that much disappointment is felt at the failure to find a place in the Abbey for a simple memorial tablet to Spencer, but there is a difference of opinion as to whether steps should be taken to establish a national memorial to him in some other form. Among the men of science who consider it would be a reproach to leave Spencer's memory unhonored are Lord Avebury, Professor Clifford Allbutt, Dr. Bastian, Sir Michael Foster, Mr. Francis Galton, Sir Joseph Hooker, Professor M'Kendrick and Professor Poulton. There is, however, a strong feeling, expressed by Sir Norman Lockyer, that while no national memorial to Darwin exists outside Westminster Abbey, it would be undesirable to attempt to raise one to Spencer by public subscription. Lord Kelvin goes so far as to remark: "I have never been of opinion that the philosophical writings of the late Mr. Herbert Spencer had the value or importance which has been attributed to them by many readers of high distinction. In my opinion, a national memorial would be unsuitable." Sir William Huggins also hesitates to support a general movement to provide a national memorial, though he agrees that a memorial tablet in the Abbey would appropriately commemorate Spencer's work. In the absence of this form of recognition, it would seem that the best way for admirers of the philosopher to show their appreciation of his work would be to establish a lectureship or scholarship in sociology, natural science, or principles of education, to issue, as suggested by Dr. A. R. Wallace, a cheap edition of his works, or in some other manner to further the objects to which he devoted his life. A movement with an end of this kind in view might be made of international interest, and would doubtless receive liberal support.

AREAS OF THE UNITED STATES, THE STATES AND THE TERRITORIES.

The question, 'What constitutes the area of the United States?' is discussed in Bulletin 302 of the United States Geological Survey, of which Mr. Henry Gannett is the author. Jurisdiction extends to a line three nautical miles from the shore, but this strip of sea can not properly be regarded as a part of the country. Supposing our country to be restricted to the sea and lake coast, there remains a question regarding the bays and estuaries. To what extent should the coast line be followed strictly, and where should we begin to jump across the indentations made by the sea? In this matter one can only follow his own judgment, making in each case as natural a decision as possible, as no definite criterion can be established. The absence of an absolute standard is in large measure the cause of the discrepancy between the tables of the Census Office, made in 1881, and those of the General Land Office, prepared in 1899, both of which show the areas of the United States and of the several states and territories.

The measurements and computations upon which these tables were based were made with great care and thoroughness in each case, and the results probably represented the areas as closely as they could be determined from the maps and charts in existence at both times. Most of the differences in these two sets of tables are trifling, amounting to only a few square miles or a small fraction of one per cent., being well within the limits of error of the planimeter and of the maps used. Some of them, however, are considerable, and a few are explained by the fact that more recent maps, which changed the position of boundaries between states, had been used by the Land Office, and its measurement was, therefore, more nearly correct. Other discrepan-

cies arose from differences in determining the coast lines.

Realizing the desirability of but one government statement of areas of the states and territories, an attempt has been made by Mr. Frank Bond, chief draftsman of the General Land Office; Mr. C. S. Sloane, geographer of the Census Office, and Mr. Henry Gannett, geographer of the Geological Survey, to come to an agreement on these figures. The results of their conference and cooperation are set forth in the aforementioned bulletin.

By this adjustment the area of the United States proper, which is given as 3,026,789 square miles, is increased over the Census Office figures by 1,188 square miles.

The area given for Alaska is 590,884 square miles. It is subject to considerable modification in the future as the position of the coast line becomes better known. The area given for the Philippine Islands is 115,026 square miles, and was determined by the Coast Survey of that archipelago, prepared at the instance of the Philippine Census. It also is subject to modification as accurate charts of the archipelago are made. The areas of Hawaii, 6,449 square miles, and Porto Rico, 3,435 square miles, are probably subject to only slight changes, as the charts from which they were measured are quite accurate. The areas given for the other small possessions of the United States, Guam, 210 square miles; Samoa, 77 square miles, and the Panama Canal strip, 474 square miles, will probably be changed in the future as their limits become more correctly defined.

SCIENTIFIC NOTES AND NEWS.

AT the last meeting of the Rumford committee of the American Academy of Arts and Sciences, the following grants for research were made: $300 to Professor Arthur A. Noyes, of the Massachusetts Institute of Technology, for the construction of a calorimeter for the determination of heat reactions at high temperatures; $200 to Professor Robert W. Wood, of Johns Hopkins University, for the continuation of his researches on the optical properties of sodium vapor.

MR. ALFRED AKERMAN, state forester of Massachusetts, has resigned to accept the Peabody chair of forestry recently endowed in the University of Georgia. He is succeeded by Professor Frank Wm. Rane, professor of horticulture and forestry at the New Hampshire College. Mr. Rane's present address is, Room 7 State House, Boston, Mass.

MR. GEORGE A. COLEMAN, M.S. (Stanford, '05), has been appointed forest supervisor in charge of the Shasta Reserve.

DUDLEY MOULTON, M.S. (Stanford, '06), at present stationed in Nebraska investigating the codlin moth, has been appointed field assistant in the U. S. Bureau of Entomology.

PROFESSOR MANSFIELD MERRIMAN, Ph.D., head of the department of civil engineering, of Lehigh University, has been granted a year's leave of absence. He will reside in South Bethlehem and will attend to the administrative duties of his department.

A COMPLIMENTARY luncheon to Professor Ronald Ross, C.B., Professor R. Boyce and Dr. J. L. Todd, in recognition of the decoration recently conferred on them by the King of the Belgians for the work done by the Liverpool School of Tropical Medicine, was given on October 1 by the Lord Mayor of Liverpool.

PROFESSOR RAYMOND H. POND, of the Northwestern University, has been awarded a research scholarship at the New York Botanical Garden for six months, beginning October 1.

THE Duke of Abruzzi is planning an expedition to the Himalaya Mountains.

DR. JOHN GIFFORD is now engaged in delivering ten lectures on 'Tropical Pomology,' at Cornell University.

M. PIERRE JANET will shortly give a course of fifteen lectures at the Harvard Medical School on 'The Symptoms of Hysteria.'

THE Harvey Society of New York announces its second course of lectures. These are given at the Academy of Medicine building, 17 West 43d Street, on Saturday evenings at 8:30 P.M. The lectures are open to the public and all interested are cordially invited to attend. The program for the year is as follows:

October 20, Professor A. E. Wright, London: 'Therapeutic Inoculation with Bacterial Vaccines.'

November 3, Professor C. A. Herter, New York: 'The Common Bacterial Infections of the Digestive Tract and the Intoxications arising from them.'

November 17, Professor W. T. Porter, Boston: 'Vasomotor Reflexes.'

December 1, Professor J. G. Adami, Montreal: 'The Myelins and Potential Fluid Crystals of the Body.'

December 15, Dr. S. J. Meltzer, New York: 'The Factors of Safety in Animal Structure and Animal Economy.'

January 12, Professor F. G. Benedict, Middletown, Ct.: 'Metabolism during Fasting.'

January 26, Professor E. B. Wilson, New York: 'Recent Studies of Heredity.'

February 9, Professor G. S. Huntington, New York: 'The Genetic Interpretation of Variations in the Genito-Urinary Tract.'

February 23, Professor W. T. Councilman, Boston: 'The Relation of Certain Leucocytes to Infectious Diseases.'

March 9, Professor Friedrich Müller, Munich: 'Neuroses of the Heart.'

THE autumn lectures to be delivered in the lecture hall of the museum building of the New York Botanical Garden, Bronx Park, on Saturday afternoons, at 4:30 o'clock, are as follows:

October 13, Dr. W. A. Murrill: 'A Summer in Europe; Some Foreign Botanists and Botanical Institutions.'

October 20, Dr. M. A. Howe: 'The Vegetation of the Florida Keys.'

October 27, Dr. C. Stuart Gager: 'How Plants Breathe.'

November 3, Dr. Arthur Hollick: 'Coal: Its Origin and Development.'

November 10, Mr. G. V. Nash: 'The Vegetation and Botanical Features of the Inaguas and Grand Turk, Bahamas.'

November 17, Dr. N. L. Britton: 'Recent Explorations in the West Indies.'

November 24, Dr. H. H. Rusby: 'The Wild Nuts and Grains of North America.'

In order to provide a method for viewing the collections of the garden under guidance, an aid will leave the front door of the museum building every week day afternoon at three o'clock, to escort all who may wish to accompany him. The routes will be as follows: Monday, hemlock forest and herbaceous garden; Tuesday, pinetum; Wednesday, fruticetum and north meadows; Thursday, deciduous arboretum, nurseries, propagating houses; Friday, public conservatories; Saturday, museums.

WE learn from *Nature* that the council of the Institution of Civil Engineers has, in addition to the medals and prizes given for communications discussed at the meetings of the institution in the last session, made the following awards in respect of other papers dealt with in 1905–6: A Telford gold medal to Mr. G. A. Denny; a George Stephenson gold medal to Professor W. E. Dalby; Telford premiums to Messrs. W. R. Baldwin-Wiseman, G. N. Abernethy, H. R. C. Blagden, M. R. Collins and James Kelly; a Crampton prize to Mr. P. T. Gask. For students' papers the awards are: Miller prizes to Messrs. Ralph Freeman, A. F. Harrison, A. J. Grindling, T. R. Grigson, J. W. D. Ball and A. Morris. Mr. A. F. Harrison also gained the James Prescott Joule medal. The awards will be presented on November 6, when an inaugural address will be delivered by the president, Sir Alexander B. W. Kennedy, F.R.S.

PROFESSOR C. A. J. A. OUDEMANNS, who formerly held a chair of botany at Amsterdam, has died at the age of eighty years.

SIR RICHARD TANGYE, head of a large engineering firm at Birmingham and the author of books on travels and industry, died on October 14, at the age of seventy-three years.

THE widow of the late Professor Gusserow would like to sell his library as a whole. The library is a very rich one and contains sets of archives, of society publications, text-books and separate volumes, and also about 4,000 separate reprints. A catalogue has been prepared of the library, the value of which has been estimated at 14,000 Marks. Further inquiries on the subject may be addressed to Professor Waldeyer, 35 Luther Strasse, Berlin, W., Germany.

THROUGH the generosity of friends the Chicago Academy of Sciences has secured 3,000 species of the Quadras collection of Mollusca, which was exhibited at the St. Louis World's

Fair. The species are mostly from the Philippine Islands, many of them being topotypes from the original lots named by Moellendorf, Hidalgo and Quadras.

THE botanical department of the University of Illinois has purchased the herbarium of George D. McDonald, of Peoria, Ill. It contains about 12,000 specimens.

IN a letter from the Congo Free State Major P. H. G. Powell-Cotton states that he has succeeded in obtaining the skeleton and skin of a fine male okapi. This animal was killed at Makala, in the Ituri forest, by the native hunter Agukki, who shot the two specimens taken to Europe by Dr. David.

THE U. S. Department of Agriculture has leased from Dr. John Gifford seven and a half acres on Elliott's Key, Dad Co., Florida, for ninety-nine years for the purpose of experimenting with tropical plants.

IT is stated in *Nature* that the authorities of the Clifton Zoological Gardens, Bristol, have recently made considerable improvements designed for the increased comfort and display of their collections. Two years ago a new lion house was built, having the cages within communicating with four open-air ones iron-barred on three sides. The animals placed in these cages showed so distinct a preference for the open air, and improved so materially, that the older range of houses has been entirely reconstructed, and was thrown open to the public on Saturday, September 22, for the first time. As now reconstructed, seven open-air cages are placed along the front of the old house, and communicate with the dens within. The cages are lofty, being between ten feet and twelve feet in height, about twelve feet wide, and fourteen feet long. They are supported upon a brickwork base four feet in height, and separated from the public by a stout iron rail, placed three feet away from the cage fronts. It is noteworthy that a Rhesus monkey was formerly kept in an outer cage in the gardens for quite a number of years, winter and summer alike, and fared well even in hard frost and snow. When taken into the monkey house, however, it quickly sickened and died.

The Electrical World quotes the following figures on the patent office congestion compiled by Mr. F. W. Barnaclo, of New York City. The office seems sorely in need of more men at better pay, for which the annual profits seem quite adequate. Mr. Barnaclo's investigation shows that in January last there were 17,353 applications awaiting action in the 39 divisions of the patent office. To date there are 24,000 cases on the docket which have not been reached for examination, and tabulations prepared by the attorney show that the office is falling behind from 250 to 300 cases a week. It is shown in the records that the average number of applications filed a week is from 800 to 1,200, and there are only about 600 patents issued a week. Among divisions behind are the following: Hydraulic motors, pumps and sewerage appliances, 11 months and 23 days behind and 1,029 cases on hand. Air and gas engines, pumps and pneumatics, 10 months behind and 993 cases on hand. Machine tools, 7 months and 19 days behind and 675 cases on hand. Elevators, journal boxes, lubricators, machine elements, pulleys and shafting, 4 months and 17 days behind and 657 cases on hand. Annealing, tempering and coating in metals, electrochemicals, metal founding, metallurgy, etc., 3 months behind and 375 cases on hand. Electric conductors, electric appliances, lighting, etc., 11 months and 7 days behind and 1,069 cases on hand. Steam engineering, 4 months and 23 days behind and 472 cases on hand. Motive power, 5 months and 25 days behind and 613 cases on hand.

AT the University of Leeds the inaugural address of the new session was delivered by Sir James Crichton-Browne upon the subject of 'Universities and Medical Education.' In the course of his remarks, as abstracted in *Nature,* he said that centuries ago gifts were given for the promotion of objects equivalent to those which modern universities hold in view, which, considering the pecuniary resources of those who gave them, should put our most open-handed modern millionaires to shame. England has been remiss of late in perceiving and promoting those interests that

hinge in scientific and medical research. In this direction Germany has stolen a march upon us, for the various governments in that empire have unstintedly provided their universities with fully-equipped research laboratories, organized and conducted by professorial directors. A university is something more than a medical school, a workshop of research, or a home of science. It must have loftier aims than material advancement or commercial prosperity. It must provide for culture in its widest sense, afford intellectual guidance, encourage individuality, take cognizance of the theoretical problems that arise in the progress of civilization, be a storehouse of knowledge, and a gymnasium for the exercise of all the powers of the mind and to be truly a university it must be an organism, and not a mere conglomeration of parts. The one great objection to the multiplication of universities is that they may tend to become local seminaries, somewhat parochial in spirit, and fed exclusively from one district, for it would be a misfortune to a boy to pass from a secondary school to a university in the next street, where he would meet as his fellow-students only his old schoolfellows, and where, however amply fed with knowledge, he would still be surrounded by the same traditions and associations and shop amongst which he had been brought up. A provincial university is a contradiction in terms. What is wanted is a group of territorial universities, each with distinctive features of its own, specially adapting it to its environment, but all affording the most liberal instruction, the finest culture, the best intellectual discipline of the day, and collectively meeting the higher educational needs of the whole country.

The Geographical Journal states that Sir Everard Im Thurn, governor of Fiji, made a journey last November across the mountainous interior of Viti Levu, from the mouth of the Sigatoka River on the one side to Ba on the opposite coast. The coast at the river-mouth is unprotected by a reef, and the big ocean waves locally called *lokas,* continually roll in, making the narrow rocky entrance precarious even for small boats, and piling up the great swelling sand-dunes characteristic of this part of Fiji only. An entrance was, however, successfully made in the steam-launch of the *Ranadi,* perhaps the first steam-craft to enter the river. After presiding at the installation of a new Roko, or native chief, the governor and his party proceeded along the bridle-road which crosses the flats of the Sigatoka and winds over the rugged interior ranges. The flats, which extend up to Fort Carnarvon, seem capable of great development agriculturally. The route led through the scenes of the war of 1876, in which Sir Arthur Gordon finally ended the long strife waged by the mountain tribes against the coast natives and Europeans. On the present occasion the travelers met everywhere with a most hospitable reception, and the outer hills struck the governor as offering great opportunities for sheep-rearing, if the native system of firing the whole country-side in search of wild yams were stopped. Further on the Nalotu range, with a wonderfully serrated crest of dolomitic rock, was crossed by a small but well-marked nick in the knife-edge, the steep descent leading through thick trees to the flats along the Ba River. On this, the northwest side of the island, is the great sugar estate of the Colonial Sugar Refining Company, extending some forty miles between the Ba and Nadi rivers, the capabilities of which considerably impressed the governor. At one of the more recently opened centers, Lautoka, the mill is one of the most up-to-date in the world, and the place has also the advantage of possessing sheltered anchorage and an excellent wharf. What is wanted, however, is the connection of its tram system with that at the other end of the estate. An interesting experiment in the reclamation of coast swampland has lately been made, the great difficulty being the washing of the salt out of the soil. From Ba the governor rode up by the excellent bridle-path to Nadarivatu (which it is hoped to develop as a sanatorium), through some of the finest mountain scenery imaginable.

Nature states that the committee of the Quekett Microscopical Club has arranged for

a series of demonstrations at 20 Hanover Square, W., on 'The Practical Use of the Microscope and its Accessories,' to be given from 7 to 8 P.M. on the third Friday in each month during the ensuing session. The first will be on November 16, when Mr. H. F. Angus will deal with axial substage illumination, including the use of the plane and concave mirrors, substage condensers and methods of centering the illuminant and of obtaining critical illumination. At other demonstrations, the order of which is not yet finally settled, the following subjects, among others, will be considered: substage non-axial illumination, including oblique and dark ground illumination; the use of the micropolariscope; various methods of illuminating opaque objects; the testing and comparison of objectives; and the employment of micrometers and finders. These demonstrations will be in addition to the 'Gossip' meetings of the club, which are held on the first Friday, and to the ordinary meetings, held also on the third Friday of the month at 8 P.M.

UNIVERSITY AND EDUCATIONAL NEWS.

MR. ALFRED C. CHAPIN has given Williams College, of which he is an alumnus, an additional gift of $50,000, to be used by the trustees without restriction. Another New York alumnus, Mr. Charles T. Barney, has given $10,000 to the college.

THE Oberlin correspondent of the New York *Evening Post* states that the half-million fund for Oberlin College, as completed, amounts to $501,608. This is divided under the following funds: $125,000 for a new library building given by Mr. Andrew Carnegie, $100,000 for library endowment, $100,000 from an anonymous donor in Boston for the increase of salaries of teachers in the college and seminary, $25,000 for an art building and its endowment, $5,000 for the Barrows' Memorial Building for Men, and $146,608 for miscellaneous purposes. The gift of the Boston donor enables the trustees to increase by $200 the salaries of twenty-four full professors. The amount of the $146,608 is devoted to the following objects: $85,000 given by Miss Anne Walworth for the endowment of the Slavic department, $15,000 given by Mr. F. Norton Finnery as an addition to the Finney Memorial Chapel fund, $21,558 for equipment and endowment in various departments, and $25,000 for new scholarships and loan funds. Of this, $10,000 is in scholarships for self-supporting women, and $10,000 is in the Gilchrist banking fund, the income of which may be used as temporary loans to students. This fund was a bequest from Ella Gilchrist Potter, of Alpena, Mich. The largest single gift toward the library endowment was that of Dr. C. N. Lyman, of Wadsworth. This amounted to $34,000. The remaining $66,000 was given by fifty-five donors in sums ranging from $10,000 to $25.

THE facilities of the engineering department of Purdue University have been increased by the completion of a building containing three floors, each 75 x 130 feet, for the department of civil engineering, and by an addition to the electrical laboratory 68 x 90 feet to give room for additional equipment. This room is to be served by a traveling crane which may be utilized in transferring heavy equipment from the laboratory to a new lecture room which adjoins. There have been added to the materials testing laboratory and to the steam engine laboratory a number of machines, including a 100,000-pound Olsen testing machine, a Fairbanks-Morse 50 horsepower gas producer and gas engine, a 20 horsepower DeLava steam turbine with direct-connected centrifugal pump, a steam Ingersoll-Rand air compressor, a Foster super-heater of the type supplied by the Power Specialty Company, a Gerry-Emmons gasoline engine, an Abner Doble water motor, and an Allis-Chalmers 8 x 24 Corliss engine, direct-connected with a centrifugal pump of 4,000 gallons capacity.

PROFESSOR W. C. SABINE, who holds a chair of physics at Harvard University and is known for his researches in acoustics and optics, has been appointed dean of the Lawrence Scientific School to succeed the late Professor Shaler.

DR. W. B. CANNON, assistant professor of physiology in the Harvard Medical School,

has been promoted to the George Higginson professorship in succession to Professor H. P. Bowditch, who has become professor emeritus. Dr. Wm. T. Porter has been promoted from an associate professorship of physiology to a chair of comparative physiology.

The administrative board for the Graduate School of Arts and Sciences of Harvard University for 1906–7 is as follows: Professors W. M. Davis, acting dean, E. L. Mark, G. F. Moore, H. W. Smyth, G. L. Kittredge, Hugo Münsterberg, W. C. Sabine, Maxime Bôcher, E. F. Gay, J. A. Walz.

Mr. W. L. Puffer, associate professor of electrical engineering at the Massachusetts Institute of Technology, has resigned and is succeeded by Professor George C. Shaad, of the University of Wisconsin.

Professor E. H. Sneath has been granted a second year's leave of absence from Yale University. Dr. Paul Monroe, professor of the history of education at Teachers College, Columbia University, will have charge of one of his courses.

Dr. Ira D. Cardiff, assistant in botany at Columbia University for the past two years, has resigned to accept the professorship of botany in the University of Utah, Salt Lake City, Utah.

Mr. Chester A. Darling, A.B. and A.M., now of Defiance College, Ohio, has become assistant of botany at Columbia University.

The following appointments are announced at Cornell University: J. C. Peebles, H. W. Riley, M. F. Thomas, George Carpenter and W. H. Van Winkle, instructors in experimental engineering; F. H. Kroger, instructor in electrical engineering; D. C. Gillespie, instructor in mathematics; Lowell B. Judson, assistant professor of horticulture.

At Dartmouth College, appointments have been made as follows: *Assistant professors,* Dr. D. H. Gerould, biology; Dr. G. M. Poor, astronomy. *Instructors,* R. M. Barton and F. C. Moore, mathematics; A. H. Chivers, biology; Dr. C. H. Johnston, philosophy. *Assistants,* F. L. Adams and C. Sheard, physics.

The following advancements in the teaching staff of Lehigh University have been announced: Assistant Professor Arthur E. Meaker, C.E., and Assistant Professor Preston A. Lambert, M.A., become professors of mathematics, and John H. Ogburn, C.E., assistant professor of mathematics; Assistant Professor John D. Irving, Ph.D., becomes professor of geology; Assistant Professor Philip M. Palmer, A.B., becomes professor of modern languages and literatures; Barry MacNutt, E.E., M.S., becomes assistant professor in physics; Assistant Professor William B. Schober, Ph.D., becomes acting professor of chemistry in charge of the department, in place of Professor William H. Chandler, Ph.D., resigned.

New appointments at Purdue University are as follows: W. K. Hatt, Ph.D., formerly professor of applied mechanics, to be professor of civil engineering in charge of the department; Mr. Paul B. Brenneman, B.S., 1894, C.E., 1897, State College of Pennsylvania, formerly engineer and superintendent of mining construction and operation, to be instructor in civil engineering; Mr. Arthur W. Cole, B.S., Worcester Polytechnic Institute, 1902, formerly of the University of Maine, to be instructor in thermodynamics; Mr. L. W. Wallace, B.S., Texas A. and M. College, 1903, late with the motive power department of the Santa Fe Railroad, to be instructor in car and locomotive design; Mr. W. T. Small, B.S., Purdue, 1903, formerly with the Cooper-Hewitt Electric Company, to be instructor in the electrical laboratory; Mr. C. E. Schutt, B.S., Purdue, 1905, formerly with the New York Telephone Company, Mr. George Lamke, B.S., University of Michigan, 1906, and Mr. W. A. Rush, B.S., Purdue, 1906, to be assistants in the electrical laboratory; Mr. R. D. Kneale, B.S., Purdue, 1906, and Mr. M. L. Allen, B.S., University of Wisconsin, 1906, to be assistants in the civil engineering department.

Mr. Robert E. Loving, Ph.D. (Johns Hopkins, '05), has been elected professor of physics at Cornell College, Iowa. Mr. Robert W. Getchell has been appointed assistant in the chemical department.

Professor Wien, of Würzburg, has declined the call to succeed the late Professor Drude, at Berlin, on the ground, it is said, that the government will not erect a modern physical laboratory.